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CASE REPORT

High pressure paint injection injury of the hand

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Case report

A 42-year-old right handed male builder sustained a 13,800 kPa (2000 psi) paint gun injection injury to his left ring finger whilst painting the exterior of an industrial tank. The paint being used was Dulux[®] Trade Weathershield Smooth Masonry Paint—Brilliant White. He presented 24 h after the injury, complaining of pain, altered sensation and limited movement of the finger. The finger was grossly swollen and a small puncture wound was noted on the radial border of the digit at the level of the proximal interphalangeal joint. White paint was readily expressed from the wound. Active movements were markedly reduced and there was paraesthesia affecting both sides of the digit. Plain film radiographs demonstrated radio-opaque paint within the soft tissues of the ring finger (Fig. 1).

A provisional diagnosis of flexor synovitis secondary to paint injection was made and the patient was admitted for emergency surgery. Under regional anaesthesia and tourniquet control the wound was excised and the incision extended until normal tissue was identified. Paint was found within the soft tissues of the finger, tracking along the neurovascular bundles and also within the flexor tendon sheath. The mid-palmar space was explored and

found to be uninvolved. Digital neurovascular bundles were identified and dissected free of any paint. Soft tissue debridement was performed with a thorough wash-out, in an attempt to remove as much paint as possible. Despite this, there was residual paint contamination of the soft tissues so the wound was left open and dressed. Post-operatively the arm was elevated and wet dressings were applied and changed regularly in an attempt to absorb the remaining paint. Intravenous broad-spectrum antibiotics were prescribed.

The patient was discharged to home 2 days later and attended hospital dressing clinic for review and dressing changes. After 1 week the patient was readmitted for further debridement and another paint washout (Fig. 2). By this stage there was minimal residual paint. Further management included delayed primary closure with skin grafting. The patient underwent a course of hand therapy and made an excellent functional recovery.

Discussion

High pressure injection injury is not common. The first reported series of injection injuries was in 1937 and was due to the fuel injection systems of diesel engines.⁹ The number of cases remained relatively small until increasing industrialisation since the 1950s has led to an increasing frequency of injury and also an increased range of substances injected.

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Figure 1 Radio-opaque paint within flexor sheath of left ring finger.

Today, the exact incidence is difficult to estimate although reports suggest the condition constitutes 1 in 600 hand injuries seen in the Emergency Department.¹⁰ Working pressures can be as high as 70,000 kPa (10,000 psi). Grease, diesel and paint are most commonly injected materials with paint carrying the worst prognosis.³

Pressures as low as 670 kPa (100 psi) are sufficient to penetrate the skin. Once through the skin, the injectant passes into the subcutaneous tissues and



Figure 2 Second look surgery demonstrating residual paint and granulation tissue.

can enter the flexor sheath or track along tissue planes and neurovascular bundles.¹ If material enters the flexor sheath then it can be transmitted into the deep spaces of the hand and forearm.¹ The extent of spread is determined by injection pressure, viscosity of injectant and the exact site of injection. It has been suggested that injections over the membranous portions of the flexor sheath enter the sheath readily, whereas injections over the fibrous portion do not breach the sheath but track along tissue planes and neurovascular bundles.⁴ Several mechanisms are involved in the pathophysiology. The jet velocity of the equipment is governed by working pressure, nozzle diameter and injectant viscosity. For paints, this can be as high as 700 km/h. The kinetic energy, given by $KE = 0.5MV^2$, of 1 ml of water delivered at these speeds is approximately 20 J, 10 times the kinetic energy of a 1 kg weight dropped from 1 m. Such high energy mechanical impact damages tissues around the injection site, causing immediate necrosis. There is vascular spasm in response to the initial trauma. Volatile organic substances such as paint cause tissue necrosis on contact and within hours generate an acute necrotizing inflammatory reaction which persists until the tissues are debrided.² Oedema secondary to trauma, and tissue distension due to the volume of injectant cause venous outflow obstruction and digital artery compression. Infection, most commonly seen in neglected injuries, can result in further extension of tissue damage and more necrosis. These mechanisms acting together result in profound ischaemia of the affected digit and are responsible for the extensive damage, poor prognosis and high rate of digital amputations (16–55%).^{8,10,5}

Clinically, young males (average age 28.4 years) are most commonly affected.⁸ There is often a history of recently starting a new job, or using new or unfamiliar equipment. The thumb and index finger are the most common sites of injury. In 75% of cases the non-dominant hand is involved. Often there is little pain at the time of the injury, which may even go unnoticed. However, the injured area soon becomes swollen and very painful with limitation of movement. A careful history of the mechanism of injury, the material injected, operating pressure and the timeline since the accident should be obtained. A thorough physical examination of the affected upper limb should be made, noting circulation in the digit and evaluating for compartment syndrome. Radiological investigations such as plain film radiography and MRI may be helpful in establishing the extent of spread of any injectant but should not delay definitive treatment.⁶

Paint injection injuries are a surgical emergency and prompt, appropriate treatment is essential. It

has been suggested that the interval from injection to treatment is a determinant of results.⁷ Once the diagnosis is suspected analgesia and broad-spectrum antibiotics should be given. Tetanus prophylaxis should be considered and the hand splinted and elevated. Digital ring block with local anaesthetic is contraindicated since this can further increase compartment pressures. Definitive treatment involves surgical decompression of the digit, removal of any foreign material and debridement of any non-viable tissues. This can be carried out under general or regional anaesthetic and the use of a tourniquet is advocated. Solvents are not indicated since they can be as damaging as the paint they are intended to remove. At the end of the procedure, the wound should be left open. A second look 48–72 h later, for further irrigation and debridement has been recommended. The wound can be closed secondarily once free of contaminant and clean. Hand therapy should be started as soon as possible to aid rapid functional recovery.

Conclusion

High pressure paint injection injury is a surgical emergency that demands prompt diagnosis and treatment if a disastrous outcome is to be avoided. Because such injuries are relatively uncommon, it is important for first line medical staff to be aware of the often benign presentation and the need for

urgent treatment. The soft tissue damage caused by such injuries is devastating and can result in poor functional outcome or amputation. Effective treatment demands prompt referral and immediate surgical intervention, followed by aggressive post-operative care and rehabilitation if acceptable results are to be achieved.

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